SAND STORMS.

Sand storms were reported during the month, as follows: San Carlos, Ariz., 3d; Fort McDowell, Ariz., 3d to 6th; Fort Mojave, Ariz., 4th to 7th; Rio Grande City, Tex., 29th, 30th.

VERIFICATIONS.

INDICATIONS.

The detailed comparison of the tri-daily indications for July, 1887, with the telegraphic reports for the succeeding thirty-two hours, shows the general average percentage of verifications to be 67.68.* The percentages for the different elements are: Weather, 67.52;* wind, 65.96;* temperature, 68.31.* By states, etc., the percentages are: For Maine, 59.52; New Hampshire, 63.82; Vermont, 61.18; Massachusetts, 66.28; Rhode Island, 75.75; Connecticut, 66.10; eastern New York, 61.23; western New York, 68.49; eastern Pennsylvania, 63.26; western Pennsylvania, 66.07; New Jersey, 67.84; Delaware, 65.00; Maryland, 66.62; District of Columbia, 66.22; Virginia, 64.60; North Carolina, 70.92; South Carolina, 71.46; Georgia, 69.98; eastern Florida, 68.74; western Florida, 70.91; Alabama, 69.94; Mississippi, 68.97; Louisiana, 71.38; eastern Texas, 81.68; Arkansas, 66.97; Tennessee, 60.85; Kentucky, 67.11; Ohio, 73.22; West Virginia, 76.05; Indiana, 75.61; Illinois, 77.63; lower Michigan, 69.10; upper Michigan, 64.08; Wisconsin, 65.04; Minnesota, 66.23; Iowa, 70.66; Kansas, 67.54; Nebraska, 55.06; Missouri, 76.28; Colorado, 58.23; eastern Dakota, 59.68; Washington Territory, 80.80; Oregon, 85.04; northern California, 91.61; southern California, 93.44.

There were fifteen omissions to predict out of 8,529, or 0.18 per cent. Of the 8,514 predictions that have been made, eight hundred and thirty-seven, or 9.83 per cent., are considered to have entirely failed; seven hundred and thirty-three, or 8.61 per cent., were one-fourth verified; 2,018, or 23.70 per cent., were one-half verified; 1,565, or 18.38 per cent., were three-fourths verified; 3,361, or 39.48 per cent., were fully verified, so far as can be ascertained from the tri-daily reports.

The predictions for all districts east of the Rocky Mountains for July, 1887, were made by 2d Lieutenant John P. Finley, Signal Corps, Assistant, except from the 17th, 3 p. m., to the 19th, 10 p. m., inclusive, when they were made by 2d Lieutenant F. M. M. Beall, Signal Corps, Assistant; those for the Pacific coast districts were made by 2d Lieutenant J. E. Maxfield, Signal Corps, Assistant; the verifications were determined by 1st Lieutenant Robert Craig, 4th Artillery, Acting Signal Officer and Assistant.

CAUTIONARY SIGNALS.

Of the total number of signals ordered during July, 1887, it was practicable to determine the justification or failure of seventy-five; of these, twenty-six, or 34.66 per cent., were fully justified both as to direction and velocity. Number of signals ordered for southeast winds, five; fully justified both as to direction and velocity, three, or 60.00 per cent. Number of signals ordered for soutwest winds, twenty-two; fully verified both as to direction and velocity, ten, or 45.45 per cent. Number of signals ordered for northwest winds, six; fully verified both as to direction and velocity, five, or 83.33 per cent. Number of signals ordered without regard to direction, forty-two; verified, eight, or 19.05 per cent. Number of signals ordered late, i. e., after justifying velocity had begun, one, or 1.33 per cent.

In addition to the above, there were ordered at display stations sixty-nine signals, the verification of which it was impracticable to determine.

In forty-two instances winds were reported which would have justified the display of cautionary signals, but for which no signals were ordered, and in eleven instances winds which would have justified the display of on-shore signals, but for which no signals were ordered. The display of on-shore signals was discontinued on July 13th.

No cold-wave signals were ordered during the month.

LOCAL VERIFICATIONS.

The following is from the report of the "Michigan State Weather Service" for July, 1887:

Weather signals are now displayed in one hundred and thirty-two towns in the state, and are very favorably commented on. The prediction of the weather for the twenty-four hours from 7 a. m. to 7 a. m. has been verified during July as follows (the verification is taken from reports of displaymen furnished monthly to this office): temperature, 82.9 per cent.; weather, 85.7 per cent.; temperature and weather, 84.3 per cent.

The weather and temperature signals are now carried on the baggage cars of the following roads: D., G. H. & M. R'y., C. & G. T. R'y., Port Huron Division G. T. R'y., P. H. & N. R'y., the Michigan Central R'y System, G. R. & I. R'y, and the Chicago and West Michigan R'y. The first trains leaving the terminal points carry the signals, and there are now twenty-five trains on these different roads that carry the signals, and cover a very large portion of the agricultural district of the state, and bring the benefits of the service within reach of the farmers along the line of these roads daily, and many favorable comments are made on the benefits derived.

The percentage of verification of weather predictions for July on the D., G. H., and M. R'y., is 84.7 for weather and 83.3 for temperature; on the C. & G. T. R'y., weather, 81.3, and temperature, 79. 7; P. H. & N. R'y., weather, 85.0, and temperature, 84.7. The other roads have not been carrying the signals sufficient time to compute the percentage.

The following is from the July, 1887, report of the "Minnesota Weather Service:"

Verifications of weather signals for Minnesota were 77 per cent. for weather and 75 per cent. for temperature; for eastern Dakota, 85 per cent. for weather and 88 per cent. for temperature.

The following is from the July, 1887, report of the "South Carolina Weather Service:"

The percentage of verification of the weather and temperature predictions for the whole state was: for weather, 84.8 per cent.; for temperature, 94.6 per cent.

The following is from the July, 1887, report of the "Tennessee State Board of Health Bulletin:"

The percentage of verification of the temperature and weather predictions during the month at Fayetteville and Clarksville were as follows: Fayetteville, temperature, 100 per cent.; weather, 71.0 per cent.; Clarksville, temperature, 87.1 per cent.; weather, 55.0 per cent.

*In determining the general average percentage and the percentages for the different elements, the Pacific coast states have not been included.

STATE WEATHER SERVICES.

The following extracts are republished from the reports for July, 1887, of the directors of the various state weather services:

The "Arkansas Weather Service," W. U. Simons, Signal Corps, director:

The month was marked by numerous local rain storms, which were distributed in a partial manner, some parts of the state having abundant daily rains, others only at intervals of several days, and in some localities only one or two sprinkles during the month, so that the total amount ranged from 8.7 inches to only .04 of an inch. These rains did not appear in belts, and it would be difficult to precisely define their location. The greatest amount of rain fell at Forrest City, in the eastern part of the state, while the next largest amount was reported from Pine Bluff in the central part, and the least at Malvern, also centrally located.

The temperature was apparently above the average at most points, but more particularly in the central and northern portions than in the southern. The temperature reached or passed 90° on over twenty days of the month at all stations except Eureka Springs, where it reached 90° on three days; at Conway on fourteen days; Portia, fifteen days; Buck's Range, seventeen days; Washington and De Vall's Bluff, each on eighteen days.

A cool wave passed over the entire state on the 23d, and there were but few points where the temperature reached 90° on that day. The highest temperature reported during the month was 109°, at Lead Hill, on the 30th, but a maximum of a hundred or over was reported from twenty-six stations. The highest temperatures of the month were observed on the 30th and 31st at most points.

There was no general storm during the month, and but one or two local wind storms; these did but little damage.

Hail was reported in Marion county on the 31st, and a very heavy thunderstorm, with particularly brilliant lightning.

The "Monthly Review of the Illinois Weather Service," Col. Charles F. Mills, director:

The month of July, 1887, was notable for its extreme heat, deficient rainfall, lack of cyclonic disturbances, and consequent casualties.

The mean temperature, eighty degrees, was four degrees above the normal temperature for the month, and is the highest mean temperature recorded in the past thirteen years. The maximum temperature, 110° was reported by a number of observers in the northern division of the state, and is six degrees above the highest July maximum temperature recorded in the past ten years. The minimum temperature of the month, forty degrees (with light frosts), was reported on a. m. of the 4th from De Kalb county, making the absolute range of temperature for the month seventy degrees, which is about fifteen degrees above the average monthly range for July. The extreme heated periods were from the 12th to 18th and 27th to 31st.

The rainfall was greatly deficient in the majority of the seventy counties reporting, twelve of which reported a total monthly rainfall of three inches and above; forty-eight reported from one to three inches; eight, less than one inch, and two, Vermillion and Effinghan, reported no rainfall. General rains fell throughout the state from 1st to 3d, the amount deposited on these dates being greater than the total for the ramainder of the month. The cool-wave of 22–23d was accompanied by heavy local showers in sections of the central and throughout the northern part of the southern division. Owing to the long-continued drought, in many sections the water supply is very scarce; creeks and wells running dry that were never known to fail, and stock suffering greatly in consequence.

The percentage of sunshine for the month was considerably above the July normal percentage, as computed from the records of the past seven years. An average of only three cloudy days was reported from the central division. The prevailing winds were southerly, and the average hourly velocity but six miles.

The "Indiana Weather Service," Prof. H. A. Huston, of Purdue University, Lafayette, director:

The pressure for July was about normal, being slightly below in some localities, and slightly above in others. The range was small, though not remarkably so. The greatest was .400 at Indianapolis and Worthington, and the least was .320 a Spiceland.

The temperature for the month has been extraordinarily high, the mean for the state being 5°.6 above the normal. At twenty-one stations the maximum reached or exceeded 100°, while at all the rest it reached 99°. At several stations a maximum of 105° was reported, while at Butlerville 106° was reported. The latter temperature has never been exceeded at any station of the State Weather Service, and has only once been reached—at Logansport in 1874. At Indianapolis it has been the hottest July in seventeen years, being 4°.1 above the mean of that period. The total number of degrees at that station was, on the 1st of August, 142° above the normal since the beginning of the year. In Wisconsin, Illinois, and Ohio the same conditions prevailed. At Milwaukee the mean for the month was only once exceeded in seventeen years, and then only three-tenths of a degree—in 1878, while the means of all the other years have been considerably lower. At Springfield, Ill., it was the hottest July in eight years, and at Toledo, Ohio, the hottest in seventeen years. This extreme temperature prevailed in a stretch of country embracing the states of Ohio, Indiana, Illinois, Wisconsin, Iowa, Nebraska, Missouri, and Kansas, in fact the great corn-growing states of the Union. South of this tier of states, however, the temperature was nowhere exceptionally high, seldom exceeding the normal.

The precipitation for the month was much below the normal, nearly three inches for the whole State. As the June precipitation was also short about the same amount, the accumulating deficiency has become quite a serious matter. The total deficiency at Indianapolis since January 1, was, on August 1, 9.58 inches. This is probably about the average for the state, and represents an enormous aggregate deficiency—nearly half a million tons to the square mile. At Indianapolis there has been only one July in seventeen years in which the rainfall has been less than this—that was in 1881, when it was 0.82 inch. It is a curious fact that at this station more rain fell during this month in the five years ending 1875 than in the twelve succeeding years up to date. It is held by some that there is a periodicity in these terms of drought and coupious rainfall, but, for so far, observation does not support such a theory—no reliable approach to periodicity has yet been discovered. The peculiar atmospheric conditions that produce drought areas from time to time in various parts of the United States are not well understood, and much has yet to be learned in that direction. Why the states of Illinois, Indiana, and Ohio should thus, this year, be parched and burned up for lack of rain, while the states to the south and northward have an average, or more than average, precipitation is a meteorological problem that yet needs a satisfactory solution.

At a few stations heavy showers were reported during the month, principally on the 4th and 21st. Muncie had 1.95 inches on the 4th, Farmland 1.07 on the same date. Richmond had 1.45 inches on the 21st, and Worthington 1.38 inches. Thunder-storms were reported on the 1st, 2d, 3d, 4th, 5th, 6th, 7th, 8th, 9th, 18th, 19th, 28th, and 31st, but none of them were very noticeable. Hail was reported at Muncie and Logansport on the 18th. The observer at Mauzy reports a gale on the 9th which blew down fences and trees in his vicinity.

Solar halos were reported at Mount Vernon on the 16th and 20th, and lunar at Vevay on the 3d, 5th, and 7th.

A very bright meteor was observed at Fortville on the 30th at 9 p. m. It started near Cassiopia and seemed to descend nearly vertically, and left a very perceptible luminous train behind it. The observer at Vevay reports another on the 2d at 8.30 p. m., very brilliant, radiating from Leo and passing south through Aquila, and leaving a luminous train visible ten seconds.

The "Iowa Weather Service," Dr. Gustavus Hinrichs, Iowa City, director:

July, 1887, was very hot, fine dry weather with southerly winds or calms prevailing. Thunder-storms and rains were frequent but generally very local.

The mean temperature of the air was 3°.5 above normal. During the past forty-eight years, July has but once been hotter in Iowa, namely in 1868. July was nearly as hot as this year in 1864, 1854, and 1845; in 1886, 1881, and 1878 it reached to within one degree of this year's temperature.

All three decades of the month were above normal; the last by 1°.0, the first by 2°.5, and the middle decade by 7°.0, which thereby ranks among the hottest decades on record. The temperature rose gradually from the 11th to the 17th, and from the 26th to the 29th; on these hottest days, heat storms with rain, thunder, and lightning, and locally high wind and hail set in, greatly lowering the temperature. The storm of the 17th was most intense in southeastern Iowa, while that of the 29th was most marked in the northeast.

Although the heat was very protracted, and on several days reached close up to the highest ever observed, we have heard of only one case of fatal sunstroke in Iowa. In other parts of the United States fatal sunstrokes were numerous, especially on Sunday the 17th. The reason of this immunity from fatal effects of heat in Iowa is the present great dryness of our air; the relative humidity on the hottest days came down to 30 per cent. Hence the apparently strange fact that threshing machines were kept running in Iowa while the thermometer ranged high in the nineties, without fatal effects to man or beast.

The sky was generally fine, the mean cloudiness being fully 25 per cent. below the normal, which itself is low for our mid-summer. Half of the days were clear, and none were entirely cloudy.

The wind was light, southerly winds and calms greatly predominating. High winds were local, and mainly limited to the 12th, 17th, and 29th.

The rainfall was generally considerably below normal in amount and on the whole came in local showers only. It rained in the state on twenty-one days, or on two out of every three days, so that the rain frequency for the entire state appears high. But on only eight of these days did the rain extend to about half of the stations reporting, and on no day did it rain throughout Iowa. The only parts of Iowa which received the normal amount of July rains form a belt from Sac over Hancock to Mitchell county, and a large area covering most of Buchanan, Benton, Linn, Iowa, and Johnson counties, where from four to six inches of rain fell. From these regions of full normal rainfall, the amount diminishes in all directions, remaining fairly satisfactory in the north and east, and running down to less than two inches in southern and middle-central parts of Iowa. In portions of southeastern Iowa, even less than one inch fell.

Flowing water, and especially ground water, has been very low. Creeks that never have been known to be dry before, have become so now, so that it is often very difficult to provide water for stock. This is due to the drought of last year having left the ground dry; this year's rains, if no drought had preceded, would have been sufficient to maintain a fair supply of water in creeks and springs.

The number of thunder-storms was high, corresponding to the frequency of local rains. Much damage has been done to property, and many cattle, horses, and several men have been killed by lightning.

Extended fogs prevailed on the 2d in the west, on the 19th in the southeast local fogs were more frequent.

A notable meteor was seen at about 8.30 p. m. on the 25th, in central Iowa and as far east as Iowa City. Northern lights were reported on the 6th.

The "Kansas Weather Service," Prof. J. T. Lovewell, Topeka, director:

The hottest July since 1874. Only two Julys on our record have been hotter, (1868 and 1874), and no preceding July has had so cloudless a sky. The rainfall was a little less than half the July average, and nearly the entire amout fell on the first day of the month. This deficiency in the rainfall, added to the serious shortage of the preceding twelve months, found the growing crops without the usual ground reserve to draw upon, and great damage has resulted, especially to the corn crop. We are now passing through a period of rain deficiency, one of which, according to our observations, occurs once in about seven years, each alternate period being one of maximum deficiency.

Mean temperature.—79°.79, which is 1°.80 above the July average. The highest temperature was 102°, on the 17th; the lowest was 55°.5, on the 24th, giving a range of 46°.5. The mercury reached 90° eighteen times. Mean at 7 a. m., 74°.85; at 2 p. m., 90°.81; at 9 p. m., 76°.74.

Rainfall.—2.14 inches, which is 2.23 below the July average. Rain in measurable quantities fell on seven days. There were four thunder showers. The entire rainfall for the seven months of 1887 now completed has been 15.92 inches, which is 5.15 inches below the average for the same months in the preceding nineteen years.

Mean cloudiness.—24.19 per cent. of the sky, the month being 13.76 per cent. clearer than usual. Number of clear days (less than one-third cloudy), 21; half clear (from one to two-thirds cloudy) 9; cloudy, more than two-thirds), 1. There were 3 entirely clear days and none entirely cloudy. Mean cloudiness at 7 a. m., 27.42 per cent.; at 2 p. m., 27.10 per cent.; at 9 p. m., 18.06 per cent.

The "Michigan Crop Report" (the state weather service is in charge of N. B. Conger, Sergeant, Signal Corps, at Lansing):

The meteorological features of the state are based upon the reports received from thirty-seven voluntary observers and eight of the United States Signal Service. Several valuable reports were not received this month in time to be used in this report.

Temperature.—The temperature for July has been above the normal. The mean temperature for the state, 74°.0, is 5°.5 above the normal. The mean temperature for the Upper Peninsula, 64°.4, is 1°.1 below the normal, while for the Southern Peninsula the mean temperature is from 3°.1 in the northern counties, to 6°.4 in the southern couties, above the normal. The mean daily maximum temperature for the state is 85°.6.

A hot wave passed over on the 15th, 16th, and 17th, when temperatures were recorded above 100°, the maximum temperature being 102°, at Marshall, on the 17th, and at Three Oaks on the 14th, 17th, and 29th. The maximum temperatures at several stations were recorded above 90° on twenty days of the month. The highest monthly mean maximum temperature, 93°.3, is reported at Hudson.

On the evening of the 22d the temperature, which had been high for the past ten days, began to fall, and reached the minimum on the morning of the 23d, of 36°.7, at Gaylord. Frost was reported from several stations in the northern part of the state. The temperature began to rise again on the 24th, and continued high for the remaining portion of the month.

Precipitation.—There has been a deficiency of rainfall in the central and southern sections, and a slight excess in the northern section and Upper Peninsula. The normal rainfall for July, for the state, is 3.32 inches, while the average has been but 2.07 inches, showing a deficiency of 1.25 inches. In the southern section the deficiency is 1.50 inches, and the central section is 1.57 inches.

Rain fell generally in the state on the 1st, 2d, 3d, and 4th, while the southern tier of counties received some on the 5th. On the 9th general rains fell, and the central section records rain on the 12th and 18th. On the 21st occurred the last general rain, and the central section records rain on the 22d in some localities, and Macomb county reports rain on the 23d. From the 22d to the 31st, however, there occurred no appreciable amount of rain in the southern and central counties, except Macomb county, on the 23d, and the drought has been severely felt in these sections.

Bay, Clinton, Allegan, Macomb, Kalamazoo, and Washtenaw counties record less than one inch of rainfall for the month.

Decatur, Van Buren county, and Chelsea, Washtenaw county, record no rain as fallen since the 4th.

Summary.

Monthly mean temperature, 74°.0; mean of maximum temperature, 97°.1; mean of minimum temperature, 47°.7; mean monthly range of temperature, 49°.4; highest temperature, 102°.0, at Marshall, date 17th; Three Oaks, date 14th, 17th, 29th; lowest temperature, 36°.7, at Gaylord, date 23d; monthly range of temperature, 65°.3.

Mean monthly rainfall, 2.07 inches.

Average movement of wind, 5,263 miles; maximum velocity and direction, 37 miles, southwest, at Mackinaw City, date 30th; average number of clear days, 14.5; average number of fair days, 12.4; average number of cloudy days, 4.1; average number of days on which .01 inch of rain fell, 8.9.

Light frosts were reported at the following stations on the 23d: East Tawas, Gaylord, Harrison; Mackinaw City, and Swartz Creek.

The "Minnesota Weather Service," Prof. Wm. W. Payne, Carleton College, Northfield, director:

The dominant features of the month were a deficiency of rainfall in the southern counties, an excess in the northern, and a temperature slightly above the normal. From the 1st to the 16th there was an excess of temperature and a slight excess of precipitation; for the week ending the 23d there was a deficiency of precipitation and a temperature slightly above the average; from the 23d to 31st, there was a lack of precipitation and an excess of temperature. At the close of the month harvesting was progressing rapidly as far north as the forty-seventh parallel. The tornadoes of the 25th, 26th, and 29th did some little damage in the vicinity of Moorhead. In some localities the oat, barley, and wheat crops were reported below the average from the effects of the dry, hot weather and chinch bugs.

Temperature.—This has varied from about normal at Saint Vincent and Duluth to 2° above at Moorhead and Saint Paul, and 1° above at La Crosse. The average temperature for the state is 72°.4; this is, respectively, 0°.2 and 1°.5 above that of the corresponding month of 1886 and 1885, and 4°.1 warmer than the preceding month of June. The warmer periods of the month were the 5th to 11th (inclusive), 13th to 16th, 19th, 25th, 29th, 31st; the maxima temperatures occurred mainly during the second of these periods. The highest reported in the state was recorded on the 15th at Pine River Dam, and was 101°; Sherburne followed with a maximum of 100° on the 11th, 16th, and 26th, while for the year previous it was 107°. At Spring Valley the maximum was 98° on the 15th and 16th, and for the preceding year 104°. At La Crosse the maximum of 98°.4, registered on the 16th, is the highest recorded since July, 1874. The dates on which the lowest temperatures were reported are the 2d, 9th, 10th, 18th, 20th to 23d (inclusive), 25th and 30th. The minimum temperature for the state is 37°, and was recorded at Pokegama Falls on the 23d; on the same date it was 39°.5 at Park Rapids, and 38°.1 on the day preceding at Saint Vincent. The minimum temperature is 7° lower than reported at any place during July, 1886, and the average of the minima temperatures for the state is 3°.2 lower. The monthly range of temperature for the state is 64°; the greatest range for any station is 58°.3, and occurred at Moorhead, while at Bird Island and Pokegama Falls the range was 55°.0. The least monthly range was 37°, and was reported from Lake Winnibigoshish and Rolling Green.

Precipitation.—The average for the state (in inches) is 3.35; this is 0.51 above that of the corresponding month of 1886, and 1.27 below that of 1885. The rainfall was fairly well destributed in the northern counties, where there was an excess, while in the southern counties there was a deficiency, which was most marked in the southeastern portion of the state; at Grand Meadow the total precipitation was only 1.43, while at La Crosse it was 1.77; at the latter station the fall was 2.88 below the average of fifteen years. The greatest precipitation was generally reported from the region of the Red River Valley and the Great Woods. Some of the heaviest total monthly falls reported were Moorhead, 6.40; Pine River Dam, 5.94; Pokegama Falls, 5.29; Leech Lake, 4.46; Lake Winnibigoshish, 4.40; Saint Vincent, 4.28; Duluth, 4.17; and Saint Paul, 3.89. This is 1.08 above the average at Moorhead, 1.37 above at Saint Vincent, 0.60 above at Saint Paul, and 0.25 above at Duluth. The dates on which precipitation was general are 1st to 4th (inclusive), 8th, 9th, 11th, 12th, 14th to 16th, 21st, 26th to 29th. Stations reporting an inch or more of precipitation, with the dates, and which fell mainly during the prevalence of thunder-storms, were: Moorhead, 1.03, 14th; Saint Vincent, 1.91, 8th, and 1.04, 14th; Duluth, 1.33, 4th; Saint Paul, 1.13, 1st; Lake Winnibigoshish, 1.50, 16th; Leech Lake, 1.21, 16th; Morris, 1.06, 3d; Red Wing, 1.00, 12th; Excelsior, 1.05, 27th; Pine River Dam, 1.12, 3d; Mankato, 1.00, 13th.

The "Mississippi Weather Service," Prof. R. B. Fulton, of the University of Mississippi, Oxford, director:

Summary.

Mean temperature, 82°; normal for July, 80°.5; highest, 102°, at Hermanville, on the 20th, and at Lake, on the 19th; lowest, 63°, at Corinth, on the 2d; absolute range of temperature, 39°.

Average depth of rainfall, 4.38 inches; greatest monthly rainfall, 8.29 inches, at Hermanville; least monthly rainfall, 0.40 inch at Corinth.

Rainfall has been generally abundant throughout all the states. A few small sections in Mississippi report a deficiency, but there has been enough to keep the crop in good condition.

Cotton and corn crops are reported as being better than for years.

While throughout the northern and eastern states the temperature for July was from two to five degrees above normal, it was very nearly normal throughout Mississippi.

The "Missouri Weather Service," Prof. Francis E. Nipher, of Washington University, Saint Louis, director:

The mean temperature for July, 1887, has been 82°.5, which is 3°.3 above the normal temperature. The month was hot throughout, the second decade being the hottest, while the first was somewhat cooler than the third. The highest temperature was 98°.8, on the 7th, and the lowest was 69°.6, on the 24th, this being the only day during the month that the temperature fell below 70°. The temperature rose to and above 90° on eighteen days during the month. The mean temperature of the past month has been exceeded but twice since 1837, viz., July 1854 and 1868, when the mean was 84° and 84°.3, respectively.

The rainfall at the central station was 2.70 inches, which is 1.89 inches below the average for July at Saint Louis. About two inches of this fell at the beginning of the month.

In the state the highest temperatures reported were: 109° at Pro Tem; 108° at Mexico; 106° at Louisiana; 104° at Sedalia and Troy; 103° at Miami; and 102° at Kirksville and Steelville. The lowest temperatures were: 54° at Oregon; 55° at Louisiana; 56° at Ironton, Kirksville, and Miami; and 56°.5 at Houstonia. The highest mean was 82°.9, at Columbia, and the lowest was 71°.3, at Springfield.

The rainfall has been below the average all over the state, excepting two small areas, one in the northeast part of the state and the other in the southeast part, where the fall was four inches. The lowest rainfall is reported from the station at Mexico, 0.73 inch, it being the only station having less than one inch.

The observer at Oregon reports the late corn is parched so badly now that rain cannot restore it. Early corn is matured and will produce an average crop of forty bushels per acre. Spring wheat and oats matured well and are turning out better than usual. Fall wheat yields below the average.

The "Nebraska Weather Service," Prof. Goodwin D. Swezey, of Doane College, Crete, director:

The month of July has been characterized by the continuance of the dry weather of the season and by the occurrence of the hottest day for ten years.

Precipitation.—Except along the lower Platte and Loup Rivers, and thence northward along the Missouri, the rainfall has been very meagre, from an inch and a half to three inches; the largest amount reported is 5.95 inches at West Point. The average for the whole state is 2.77, while the normal for July is 4.20, as deduced from the past ten years. The distribution in time has not been so far out of the way, the number of rainy days being 7.7 against a normal of 7.9, but, in general, the ground had become so dry and hot that the smaller amounts received did not do their work. It is to be noted that for a whole year preceding this month, the monthly rainfall has been almost regularly below the normal amount, as will be seen from the following tble:

Rainfall.

Month.	Actual.	Normal.	Month.	Actual.	Normal.
1886.	*Inches.*	*Inches.*	1887.	*Inches.*	*Inches.*
July	1.31	4.82	January	.46	.88
August	2.97	3.07	February	1.06	.92
September	3.59	2.69	March	.36	1.11
October	1.25	2.47	April	1.62	2.81
November	1.26	.96	May	3.04	4.26
December	.90	.82	June	4.24	4.97
			Total	21.06	29.78

In other words, the soil entered upon its season of summer heat and drying this month with about seven and one-half inches less of rainfall since the preceding summer, than the normal amount, making it, on the whole, one of the most trying season for crops, young trees, grass, etc., that we have experienced since "grasshopper days." In fact, we must go back to March, 1886, with its unprecedented snowfall, to find a month with precipitation notably above the normal.

Temperature.—The mean temperature has not been greatly above the normal, about one degree. The noon temperature has been 3° above the normal, and the maximum temperature on the afternoon of the 29th reached 103°, both at Crete and Omaha, a temperature higher than any before reported for the ten years that our records have been kept. The lowest temperature of the month, 47°, is also lower than any reported during that period.

Wind.—On the afternoon of the 29th, before mentioned as the hottest day on record, the only tornado that has done any serious damage in the state for a number of years swept David City, killing several persons and destroying a considerable part of the town.

There has been a notable lack of thunder and hail storms, no hail, in fact, being reported from any part of the state. The clouds have been light and fleecy, and there have been but three days on the average in which the sky would be designated cloudy.

The "New Jersey Weather Service," Prof. George H. Cook, of the Agricultural College, New Brunswick, director:

The month has been characterized by excessive heat and humidity and violent storms. The largest rainfall reported for the month was 15.29 inches at Hightstown. On the 22d, 5.40 inches fell at Matawan, causing damage to the amount of $10,000. At Phillipsburg, Warren Co., on the night of the 23d, a very severe thunder-storm occurred. The lightning struck a smokestack on the Delaware Rolling Mill, and it fell against another high stack and both crushed in the roof over the hot furnace. A heavy shaft in the mill was also cut in two by the lightning. The Judd carriage factory near by was completely demolished. Hamlin's barn was blown over and four horses were buried in the ruins. A car loaded with ice, on the Lehigh Valley Railroad, was blown down an embankment, and several houses in different parts of Phillipsburg were unroofed and many trees were uprooted. The damage, so far as known, will not be less than $20,000.

The mean temperature at ten stations as compared with normals determined from past records of New York City, Atlantic City, Paterson, Newark, South Orange, Somerville, Moorestown, Philadelphia, Lambertville, and New Brunswick, shows an excess of heat received during July of 3°.3.

The "New England Meteorological Society," Prof. Wm. H. Niles, of the Institute of Technology, Boston, Massachusetts, president:

The month as a whole has been unusually warm and wet, and as a consequence, sultry and oppressive. The greatest heat was during the first four days, in continuation of the hot weather at the end of June; the coolest days were the 11th, 15th, 16th, and 21st, the minimum of the month occurring generally on the second or last of the dates mentioned. The heaviest rain fell on the 23d and 24th; thunder-storms were frequent and severe, and many foggy days are reported.

Mrs. E. J. Doton reports from Woodstock, Vt., in continuation of the records of the late Hosea Doton, that July, 1887, is the warmest month for the last nineteen years. Mr. H. D. A. Ward, of Middletown, Conn., compares the daily means of July, 1887, with the daily means of twenty-nine Julys, and finds an excess on all but six days; the mean of the month is higher than that of all previous records, except for July, 1868, when the mean was 74°.62.

The weather of the month may be considered under eleven alternating dry and wet periods, as determined by barometric changes.

(1) The heat of the end of June continued during the first four days of July, while the pressure was higher to the south, and most stations had their highest maximum on the 2d. The maximum temperatures at several stations are of interest.

Stations.	1st.	2d.	3d.	4th.	Stations.	1st.	2d.	3d.	4th.
	°	°	°	°		°	°	°	°
Shelburne, N. H	91	96	83	94	Bar Harbor, Me	86.5	91	85.8	81.8
Nashua, N. H. *a*	92.3	96.7	93.3	90	Manchester, Mass	88.5	78	82	74
Woodstock, Vt	94	96	92	92	Nantucket, Mass. *a*	80	78	80	83
Amherst, Mass	91.6	93.6	91	87.8	Nantucket, Mass. *b*	76.2	73.5	73.9	77
Framingham, Mass	94	96	97	89	Newport, R. I	77.5	75.5	76	75
Hartford, Conn	91.5	95	93.7	88	New London, Conn	86	85	84	82

(2) With the approach of a faint cyclonic disturbance on the 5th and its passage over Canada on the 6th, rains were reported at many stations until the 7th; this, however, caused little relief from the heat as the winds were still southerly. (3) The 8th was generally fair and warmer, before (4) the arrival of another moderate cyclone, that came from the Lakes on the 9th, and passed over New England on the 10th, causing numerous showers and some violent thunder-storms until its northwesterly winds on the 11th brought fair and temporarily cooler weather. (5) The fair weather lasted from the 12th to the 15th; warm at first, when the pressure was highest in the south, and thus those stations that had not reached their month's maximum on the 2d found it on the 13th, when temperatures from 88° to 96° were generally recorded; then the approach of an anti-cyclone over the Lakes on the 14th, and across New England on the 15th, brought northwesterly winds and moderate temperatures, and minima as low as 50° in the northern valleys, and 55° to 60° in the south on the early morning of the 16th; this was the lowest of the month at many stations.

(6) During the 16th, 17th, and 18th, the greater part of New England fortunately escaped the extreme heat that affected the states to the south and west. High pressure on the southern states drove the air northward, and the temperature rose from 95° to 100° in Philadelphia and cities to the westward, but excepting in southwestern Connecticut, few of our stations reported maxima above 85°, and many had during this period no maximum over 80°. This was in great part due to the passage of a gentle cyclonic disturbance from Canada over New England, giving us southeasterly or easterly winds, rain and thunder-storms, while the rest of the country had light southwesterly winds and scorching sunshine. (7) Fair weather followed, with moderate temperature on the 19th and 20th.

(8) A wet period from the 21st to the 24th, caused by the passage of a cyclone from Illinois over the Lakes and Canada, maintained moderate temperatures and gave excessive rainfall to certain stations; the largest measures are here quoted:

Stations.	23d.	24th.	21st to 24th.
	Inches.	*Inches.*	*Inches.*
Deerfield, Mass	1.02	5.39	7.51
Northampton, Mass	0.89	5.51	7.16
Manchester, N. H. *a*	2.95	3.75	7.49
Manchester, N. H. *b*			7.08
Manchester, N. H. *c*	2.60	2.57	5.71
New Hartford, Conn			6.72
Boyd's Corners, N. Y	6.01	3.00	10.09

Thunder-storms were generally reported on the 23d and 24th.

The remaining days of the month may be considered as (9) warm and generally fair from the 25th to the 28th, but with showers on the 26th and 28th; the distribution of pressure during this period being ill-defined, except in the Gulf states, where a cyclone hovered about for several days; and (10) showery and hot on the 31st, when a faint cyclone passed north of us over Canada. Many thunder-storms occurred during these two periods, the storms of the 31st being especially severe in Connecticut.

Auroras were recorded at a few stations on July 13th, 15th, 18th, 19th and 20th.

A small but brilliant meteor was seen by Mr. Higgins at West Milan, N. H., on the night of July 3d, moving from northwest to southeast.

"Oregon Weather Service," report prepared by B. S. Pague, Private, Signal Corps:

Temperature.—The temperature has been nearly normal throughout the state. A warm period extended over the state from the 5th to 8th; a cool period from the 12th to 18th. A noticeable feature is the fact that during the extreme heat prevailing throughout the east on the 16th and 17th, here we had our coolest period. The highest temperatures recorded were 106° at Umatilla on the 19th, and 103° at Ashland on the 8th; the lowest recorded were 26° at Fort Klamath on the 14th and 15th. A special characteristic of the temperature in the valleys was the few extreme warm days, and the great number of cool days. The nights were more than usually cool.

Rainfall.—The rainfall was below the average. An occasional shower fell along the Columbia from Portland to the ocean, but no rain in the Willamette Valley. One shower fell in the Umpqua Valley; from one to three showers in the Rogue River valley and the southern counties through the lake region; more rain fell in this latter section than in any other part of the state. Oc-

casional showers fell along the coast, and light sprinkles in the eastern part of the state.

Winds.—The winds were generally light to fresh from a westerly direction.

Frosts.—Occasional frosts are reported at Fort Klamath from the 11th to 25th, and a very light frost at Baker City on the 13th. At East Portland light frost occurred from the 10th to 14th, inclusive. Frosts occurred in the mountain regions or along the foot hills from 12th to 17th; they were light and no damage is reported. Frost in July is unusual.

The "South Carolina Weather Service," Hon. A. P. Butler, Commissioner of Agriculture for South Carolina, director:

The month has been chiefly remarkable for the unusually high temperature which prevailed during the second decade, and for the abundant rains which occurred during the closing days.

The temperature began to rise on the 12th, on which date Hampton and Bennettville reported maximum readings of 100° each. On the following day, 13th, the maxima were: Hampton, 103°; Bennettsville, 101°; Brewer Mine, 100°; and Chester, 104°. The temperature continued to increase over all sections of the state until the 18th and 19th, on which dates the highest temperatures of the month were reported.

At Charleston the mean temperature, 81°.7, was slightly below the average of the last sixteen years. In the rest of the state it was normal or slightly above.

The heavy rains of the 29th and 30th were caused by the passage of a cyclone which formed in the Gulf of Mexico prior to the 27th; on that date it was central near Pensacola, Fla., whence it moved north-northeastward into Alabama. From the 29th until the 31st the cyclonic area increased and spread over Alabama, Georgia, South Carolina, and northern Florida, and was attended by heavy rains, with tornadoes, in Alabama, Georgia, and our state.

Summary.

Mean temperature for the state, 82°; highest temperature, 110°, at Chester, on the 18th; lowest temperature, 60°, at Spartanburg on the 1st and 3d; range of temperature, 50°; greatest daily range of temperature, 39°, at Spartanburg, on the 1st; least daily range of temperature, 2°, at Newberry, on the 29th.

Mean depth of rainfall, 7.49 inches; greatest monthly rainfall, 13.62 inches, at Blackville; least monthly rainfall, 2.79 inches, at Jacksonborough; greatest daily rainfall, 3.70 inches at Abbeville on the 30th; least daily rainfall, trace (amount inappreciable), at Spartanburg and Abbeville on the 18th, and at Anderson and Hampton on the 19th.

Average number of rainy days, 14.4.

The following is an extract from the report of the "Meteorological Department of the State (Tennessee) Board of Health," prepared under direction of J. D. Plunkett, M. D., President of the State Board of Health, by H. C. Bate, Signal Corps, Assistant, Nashville:

The month of July presented the usual amount of electrical disturbances, but the principal feature was the excessive and unprecedented heat during the latter half of the month.

The mean temperature was 78°.8, considerably above the normal, and the highest mean for many years. The minimum was 56° recorded on the 1st, and was the highest July minimum since 1883. The hot wave which came about the 10th, culminated generally about the 17–19th, but continued with a slight relaxation until the close of the month, and was the longest warm spell ever known. The ranges of temperature were about the normal.

The precipitation was rather below the average, the mean being 3.32 inches; of this amount, the eastern division received an average of about four inches, and the other two divisions about three inches. The week of the 14–20th was the "dry week," and with the exception of a few local rains in east Tennessee, and two or three in the western part of the state, there was a serious absence of precipitation. It was during this period that the hot wave culminated and was so severely felt. Many of the rains were attended with severe electric storms, some of which were very destructive to life and property. The proportion of cloudiness was about the normal.

Summary.

Mean temperature, 78°.8; highest temperature, 101°, on the 18th and 30th, at Milan, and on the 29th, at Austin; lowest temperature, 56°, on the 1st, at Farmingdale; range of temperature, 45°; mean monthly range of temperature, 31°.1; greatest monthly range of temperature, 42°, at Farmingdale; least monthly range of temperature, 25°, at Waynesborough; mean daily range of temperature, 15°.8; greatest daily range of temperature, 32°, on the 1st and 19th, at Farmingdale, and on the 18th, at Hohenwald; least daily range of temperature, 2°, on the 6th, at Rogersville, and on the 24th, at Beech Grove; mean of maximum temperatures, 98°.0; mean of minimum temperatures, 66°.8.

Average number of clear days, 11.3; average number of fair days, 11.5; average number of cloudy days, 8.2; average number of days on which rain fell, 11.5.

Mean depth of rainfall, 3.32 inches; mean daily rainfall, 0.107 inch; greatest rainfall, 5.67 inches at Grief; least rainfall, 0.80 inch, at Woodstock; greatest local daily rainfall, 2.13 inches, on the 24th, at Florence Station.

Days of greatest rainfall, 4th, 5th, 6th, 7th, 21st, 24th; day of greatest rainfall, 24th; day without rainfall, 15th.

Warmest days, 19th, 30th, 31st; coldest day, 1st.

Prevailing winds, south and southwest.

NOTES AND EXTRACTS.

COINCIDENCE OF SUN SPOTS WITH THUNDER-STORMS AND AURORAS.

The following extract is published in view of the general interest in sunspot investigations:

As the result of the extended series of observations described, it has been found in general that whenever groups of faculæ, with or without dark spots, are appearing by rotation or are bursting forth upon the earthward side of the sun there is an immediate increase in thunder-storms in the lower latitudes, and probably of auroras in the higher latitudes. If, however, the aurora becomes visible nearer the equator at such times, there is an immediate, though perhaps temporary, decrease in thunder-storms, as though the aurora had taken their place. In short, the aurora and thunder-storms appear to have a common origin, and in certain localities, at least, a reciprocal relation to each other. Instances have been noted also in which an aurora in the United States has been coincident with unusual electrical storms in Europe, and vice versa.

The relation between the various phenomena is such that if an increase of thunder-storms or auroras is noted, faculæ coming into view by rotation or bursting forth elsewhere upon the sun may be looked for with confidence. On the other hand the appearance upon the sun of bright faculæ betokens an immediate increase in the electrical phenomena attending the storms which may be prevailing at the time anywhere on the face of the earth, unless an aurora should intervene, as has already been noted.

In general the disturbed solar and terrestrial conditions increase or diminish in like ratio. The curious fact has been noted, however, that a single disturbance occupying the sun's disc alone seems to have a more marked effect than a succession of such disturbance as though variability of tension rather than the maintenance of high tension were most concerned in the production of the phenomena in question. Aside from this, and as a rule, however, there is an evident proportion between the extent of the disturbances on the sun and those on the earth. Neither auroras nor thunder-storms become universal, but are distributed in accordance with laws which it is not proposed to discuss at present. The point is that under known limitations and in definite localities there is an increase in these phenomena whenever the solar conditions are favorable, and no such increase has been noted at any other time.

As is the case with auroras and thunder-storms, the disturbances of earth currents, known as magnetic storms, are subject to limitations and do not prevail with equal intensity at any one time over the entire surface of the globe.

The forces manifest in thunder-storms and auroras being of the character and having the origin that has been described, the question arises as to whether these forces are concerned also in the production of the movements of the atmosphere with which they are associated. (By M. A. Veeder, in The Electrical World, Vol. X. No. 9.)

EFFECT OF RAINFALL UPON TEMPERATURE OF THE AIR.

From Saturday, July 16th, to Sunday, July 24th (both inclusive) there fell 7.3 inches of rain, as measured in a rain-gauge at my residence on the Ridgewood Road, Maplewood, situated about one-third up the slope of the Orange Mountain, and exactly fourteen miles due west from New York City. There are 43,560 square feet on an acre; and 7.3 inches equals 0.608 of a foot; 43,560 x 0.608 equals 26,484 cubic feet to the acre. * * * Now it has been determined by accurate experiments, that if we could put all the heat given out by the burning of twenty pounds of dry white pine into a cubic foot of water, it would convert the water entirely into vapor, having the ordinary temperature (say 60°) of the air.

When vapor condenses into water, the heat which kept it as vapor must evidently go out from it. The data gives us some curious figures. As we had a fall of 26,484 cubic feet to the acre, it would require 20 x 26484, or 529,680 pounds of dry pine wood to send this mass of water again into vapor. A cord of dry white pine is said to weigh 1,868 pounds, and 529,580 divided by 1,868 gives 283 cords as the quantity of pine wood required, in burning, to evaporate our recent rainfall on an acre; and before that rain could fall on the acre, just as much heat as is given out in the burning of 283 cords of pine wood had to be lost to the vapor and given out to the air above us. Should we be surprised that a fall of rain (except it be very cold) rarely cools the air? [A. M. Mayer, in Scientific American, No. 6, vol. lvii.]

The above extract will be of interest in connection with the consideration of rainfall as a modifier of high summer temperatures. It should be remembered that the heat liberated by condensation is usually at quite an elevation above the earth surface, and its influence upon the surrounding air will generally cause it to rise instead of falling to the earth. At the same time the stratum of air next to the earth is being charged by vapor produced from the rainfall coming in contact with the heated earth. This evaporation will cause